Introducing the Next Generation Science Standards

April 11, 2013

Lacey Wieser
Director K-12 Science Education
Lacey.wieser@azed.gov

Arizona Department of Education

Overview for Today

Provide information about the NGSS

- Understand the adoption process in AZ
- Navigate the standards documents
- Understand the appendix documents

NEXT GENERATION SCIENCE STANDARDS

For States, By States

NGSS is Released
Now what?

1. Collect feedback and determine support for adoption.
2. Determine adoption and implementation timeline.
3. Determine assessment requirements and assessment timeline. (current AIMS science through Spring 2016, possibly longer)
4. Determine PD needs and support materials needed for implementation.

The State Board must adopt the NGSS before they become Arizona's Science Standards.

NEXT GENERATION SCIENCE STANDARDS

For States, By States

What's Different About the Next Generation Science Standards?

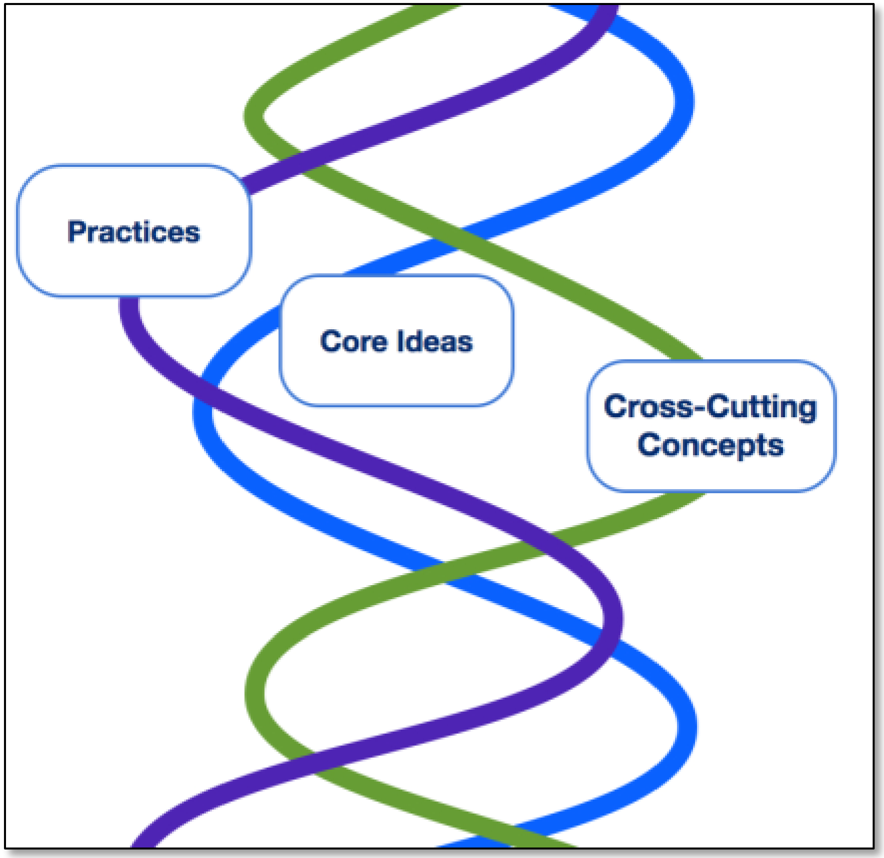
Conceptual Shifts in the NGSS

1. Reflect the interconnected nature of science and engineering as it is practiced and experienced in the real world.
2. Provide student performance expectations, not curriculum
3. Build science concepts coherently from K-12
4. Focus on deeper understanding and application of content
5. Integrate science and engineering K-12
6. Prepare students for college, career, and citizenship
7. Align with the Common Core State Standards (English Language Arts and Mathematics).

See Appendix A for more details

NEXT GENERATION SCIENCE STANDARDS For States, By States

Three Dimensions Intertwined



- The NGSS are written as Performance Expectations
- NGSS will require contextual application of the three dimensions by students.

NEXT GENERATION SCIENCE STANDARDS
For States, By States

NEXT GENERATION SCIENCE STANDARDS

For States, By States

Feedback Data from the May 2012 NGSS Public Draft

General Strengths of the Drafts

- Pedagogical Vision
- Architecture, including integration of the three dimensions
- Rigor required by the NGSS at all grades
- Web presentation and interactivity
- NGSS are well structured and clear about expectations
  - Clarification statements and assessment boundaries support additional clarity
- Intentional connections to other NGSS and Common Core standards

See Appendix B for specific details

NEXT GENERATION SCIENCE STANDARDS For States, By States

General Areas for Improvement

- Clarity of language
- Integration of critical areas
  - mathematics, engineering, crosscutting concepts
- Scope of required content
- Confusion about the role of standards versus curriculum
- Concern about organization of the standards versus *Framework* in terms of coding and arrangement
- Concern about the support that will be needed to implement the standards
  - Professional development, materials, administrator support and understanding, future assessments

NEXT GENERATION SCIENCE STANDARDS For States, By States

Changes to the Drafts

- 95% of the Performance Expectations have been rewritten, with more specific and consistent language used
- A review focused on college- and career-readiness resulted in the removal of some content (see Appendix C, coming soon)
- Some content shifted grade levels in elementary
- Engineering has been better integrated into the traditional science disciplines
- More math expectations have been added to the performance expectations
- Nature of Science concepts have been highlighted throughout the document
- The Science and Engineering Practices matrix has been revised to provide more clarity

NEXT GENERATION SCIENCE STANDARDS
For States, By States

NEXT GENERATION SCIENCE STANDARDS
For States, By States

What questions do you have?

Next Generation Science Standards Final Release

Supplementary Documents for NGSS Public Release II

- Supplementary Documents and Materials Available at nextgenscience.org
    - NGSS Front Matter
    - NGSS Structure (How to read the NGSS)
    - Commonly Used Abbreviations
    - Why Standards Matter?
- Additional Aspects of the NGSS
    - Flexibility viewing the standards with two arrangements of the performance expectations: by topics and by disciplinary core ideas (DCI)
    - Additional flexibility to the website views, allowing users to turn off “pop up” description boxes (coming soon)

NEXT GENERATION SCIENCE STANDARDS
For States, By States

NEXT GENERATION SCIENCE STANDARDS
For States, By States

News | FAQ | Contact

SIGN UP TODAY FOR EMAIL UPDATES

HOME | ABOUT THE DEVELOPMENT | WHY SCIENCE STANDARDS? | NEXT GENERATION SCIENCE STANDARDS | IMPLEMENTATION

1 2 3 4 5 6 7 8 9

CURRENT PHASE

The Next Generation Science Standards are released

Explore the standards

About NGSS

Next Generation Science Standards for Today's Students and Tomorrow's Workforce: Through a collaborative, state-led process managed by Achieve, new K–12 science standards are being developed that will be rich in content and practice, arranged in a coherent manner across disciplines and grades to provide all students an internationally benchmarked science education. The NGSS will be based on the *Framework for K–12 Science Education* developed by the National Research Council.

Latest News

Final Next Generation Science Standards Released
April 09, 2013

Update on the Final Release of the Next Generation Science Standards
March 28, 2013

NSTA Statement on Release of Second Public Draft of the Next Generation Science Standards

Resources

Watch a webinar about the NGSS

Contact Us | Press | Terms | Site Map

www.nextgenscience.org

NEXT GENERATION SCIENCE STANDARDS For States, By States

News | FAQ | Contact

SIGN UP TODAY FOR EMAIL UPDATES

HOME | ABOUT THE DEVELOPMENT | WHY SCIENCE STANDARDS? | NEXT GENERATION SCIENCE STANDARDS | IMPLEMENTATION

The Next Generation Science Standards

Printer-friendly version

The Next Generation Science Standards are now available. Twenty-six states and their broad-based teams worked together with a 41-member writing team and partners throughout the country to develop the standards.

NGSS Front Matter

NGSS Structure

Appendices to the NGSS:

A. Conceptual Shifts
B. Responses to May Public Feedback
C. College and Career Readiness (Coming Soon)
D. All Standards, All Students (Coming Soon)
E. Disciplinary Core Idea Progressions
F. Science and Engineering Practices
G. Crosscutting Concepts
H. Nature of Science
I. Engineering Design in the NGSS
J. Science, Technology, Society, and the Environment
K. Model Course Mapping in Middle and High School (Coming Soon)
L. Connections to CCSS-

Download PDFs of the NGSS:

Arranged by Disciplinary Core Idea (DCI)

Arranged by Topic

Interactive versions of the standards will be available soon.

The NGSS are composed of the three dimensions from the NRC Framework. Click on the links to the left to learn more about the standards

NEXT GENERATION SCIENCE STANDARDS

03:43 HD vimeo

DCI Arrangement Coding

2-LS2 Ecosystems: Interactions, Energy, and Dynamics

2-LS2 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

2-LS2-1. Plan and conduct an investigation to determine if plants need sunlight and water to grow. [Assessment Boundary: Assessment is limited to testing one variable at a time.]

2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.*

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions. ▪ Develop a simple model based on evidence to represent a proposed object or tool. (2-LS2-2) **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. ▪ Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-LS2-1)	**LS2.A: Interdependent Relationships in Ecosystems** ▪ Plants depend on water and light to grow. (2-LS2-1) ▪ Plants depend on animals for pollination or to move their seeds around. (2-LS2-2) **ETS1.B: Developing Possible Solutions** ▪ Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. *(secondary to 2-LS2-2)*	**Cause and Effect** ▪ Events have causes that generate observable patterns. (2-LS2-1) **Structure and Function** ▪ The shape and stability of structures of natural and designed objects are related to their function(s). (2-LS2-2)

Connections to other DCIs in this grade-level: will be available on or before April 26, 2013.

Articulation of DCIs across grade-levels: will be available on or before April 26, 2013.

Common Core State Standards Connections: will be available on or before April 26, 2013.

ELA/Literacy –

Mathematics –

NEXT GENERATION SCIENCE STANDARDS
For States, By States

Topic Arrangement Coding

2.Interdependent Relationships in Ecosystems

2.Interdependent Relationships in Ecosystems

Students who demonstrate understanding can:

2-LS2-1. Plan and conduct an investigation to determine if plants need sunlight and water to grow. [Assessment Boundary: Assessment is limited to testing one variable at a time.]

2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.*

2-LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats. [Clarification Statement: Emphasis is on the diversity of living things in each of a variety of different habitats.] [Assessment Boundary: Assessment does not include specific animal and plant names in specific habitats.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions. • Develop a simple model based on evidence to represent a proposed object or tool. (2-LS2-2) **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. • Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question. (2-LS2-1) • Make observations (firsthand or from media) to collect data which can be used to make comparisons. (2-LS4-1) --------------------------------- *Connections to Nature of Science* **Scientific Knowledge is Based on Empirical Evidence** • Scientists look for patterns and order when making observations about the world. (2-LS4-1)	**LS2.A: Interdependent Relationships in Ecosystems** • Plants depend on water and light to grow. (2-LS2-1) • Plants depend on animals for pollination or to move their seeds around. (2-LS2-2) **LS4.D: Biodiversity and Humans** • There are many different kinds of living things in any area, and they exist in different places on land and in water. (2-LS4-1) **ETS1.B: Developing Possible Solutions** • Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. *(secondary to 2-LS2-2)*	**Cause and Effect** • Events have causes that generate observable patterns. (2-LS2-1) **Structure and Function** • The shape and stability of structures of natural and designed objects are related to their function(s). (2-LS2-2)

Connections to other DCIs in this grade-level: will be available on or before April 26, 2013.

Articulation of DCIs across grade-levels: will be available on or before April 26, 2013.

Common Core State Standards Connections: will be available on or before April 26, 2013.

ELA/Literacy –

Mathematics –

Topic Arrangement Coding

NEXT GENERATION SCIENCE STANDARDS For States, By States

Second Grade

The performance expectations in second grade help students formulate answers to questions such as: "How does land change and what are some things that cause it to change? What are the different kinds of land and bodies of water? How are materials similar and different from one another, and how do the properties of the materials relate to their use? What do plants need to grow? How many types of living things live in a place?" Second grade performance expectations include PS1, LS2, LS4, ESS1, ESS2, and ETS1 Disciplinary Core Ideas from the *NRC Framework*. Students are expected to develop an understanding of what plants need to grow and how plants depend on animals for seed dispersal and pollination. Students are also expected to compare the diversity of life in different habitats. An understanding of observable properties of materials is developed by students at this level through analysis and classification of different materials. Students are able to apply their understanding of the idea that wind and water can change the shape of the land to compare design solutions to slow or prevent such change. Students are able to use information and models to identify and represent the shapes and kinds of land and bodies of water in an area and where water is found on Earth. The crosscutting concepts of patterns; cause and effect; energy and matter; structure and function; stability and change; and influence of engineering, technology, and science on society and the natural world are called out as organizing concepts for these disciplinary core ideas. In the second grade performance expectations, students are expected to demonstrate grade-appropriate proficiency in developing and using models, planning and carrying out investigations, analyzing and interpreting data, constructing explanations and designing solutions, engaging in argument from evidence, and obtaining, evaluating, and communicating information. Students are expected to use these practices to demonstrate understanding of the core ideas.

What questions do you have?

NEXT GENERATION SCIENCE STANDARDS

For States, By States

Appendices and Supplementary Documents

New Content

- Appendices have been added to support the NGSS in response to feedback
  - Appendix A – Conceptual Shifts
  - Appendix B – Responses to May Public Feedback
  - Appendix C – College and Career Readiness (Coming Soon)
  - Appendix D – All Standards, All Students Readiness (Coming Soon)
  - Appendix E – Disciplinary Core Idea Progressions
  - Appendix F – Science and Engineering Practices
  - Appendix G – Crosscutting Concepts
  - Appendix H – Nature of Science
  - Appendix I – Engineering Design in the NGSS
  - Appendix J – Science, Technology, Society, and the Environment
  - Appendix K – Model Course Mapping in Middle and High School (Coming Soon)
  - Appendix L – Connections to CCSS-Mathematics (Coming Soon)
  - Appendix M – Connections to CCSS-ELA Literacy (Coming Soon)

NEXT GENERATION SCIENCE STANDARDS
For States, By States

Appendix E: DCI Progressions

Earth Space Science Progression

INCREASING SOPHISTICATION OF STUDENT THINKING

	K-2	3-5	6-8	9-12
ESS1.A The universe and its stars	Patterns of movement of the sun, moon, and stars as seen from Earth can be observed, described, and predicted.	Stars range greatly in size and distance from Earth and this can explain their relative brightness.	The solar system is part of the Milky Way, which is one of many billions of galaxies.	Light spectra from stars are used to determine their characteristics, processes, and lifecycles. Solar activity creates the elements through nuclear fusion, and short-term solar variations cause space weather and insolation changes that significantly affect humanity. The development of technologies has provided the astronomical data that provide the empirical evidence for the Big Bang theory.
ESS1.B Earth and the solar system		The Earth's orbit and rotation, and the orbit of the moon around the Earth cause observable patterns.	The solar system contains many varied objects held together by gravity. Solar system models explain and predict eclipses, lunar phases, and seasons.	Kepler's laws describe common features of the motions of orbiting objects. Observations from astronomy and space probes provide evidence for explanations of solar system formation. Changes in Earth's tilt and orbit cause climate changes such as Ice Ages.
ESS1.C The history of planet Earth	Some events on Earth occur very quickly; others can occur very slowly.	Certain features on Earth can be used to order events that have occurred in a landscape.	Rock strata and the fossil record can be used as evidence to organize the relative occurrence of major historical events in Earth's history.	The rock record resulting from tectonic and other geoscience processes as well as objects from the solar system can provide evidence of Earth's early history and the relative ages of major geologic formations.
ESS2.A Earth materials and systems	Wind and water change the shape of the land.	Four major Earth systems interact. Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, organisms, and gravity break rocks, soils, and sediments into smaller pieces and move them around.	Energy flows and matter cycles within and among Earth's systems, including the sun and Earth's interior as primary energy sources. Plate tectonics is one result of these processes.	Feedback effects exist within and among Earth's systems. Radioactive decay and residual heat of formation within Earth's interior contribute to thermal convection in the mantle.
ESS2.B Plate tectonics and large-scale system interactions	Maps show where things are located. One can map the shapes and kinds of land and water in any area.	Earth's physical features occur in patterns, as do earthquakes and volcanoes. Maps can be used to locate features and determine patterns in those events.	Plate tectonics is the unifying theory that explains movements of rocks at Earth's surface and geological history. Maps are used to display evidence of plate movement.	

Appendix F: Science and Engineering Practices / Matrix

Practice 2 Developing and Using Models

> *Modeling can begin in the earliest grades, with students' models progressing from concrete "pictures" and/or physical scale models (e.g., a toy car) to more abstract representations of relevant relationships in later grades, such as a diagram representing forces on a particular object in a system.* (NRC Framework, 2012, p. 58)

Models include diagrams, physical replicas, mathematical representations, analogies, and computer simulations. Although models do not correspond exactly to the real world, they bring certain features into focus while obscuring others. All models contain approximations and assumptions that limit the range of validity and predictive power, so it is important for students to recognize their limitations.

In science, models are used to represent a system (or parts of a system) under study, to aid in the development of questions and explanations, to generate data that can be used to make predictions, and to communicate ideas to others. Students can be expected to evaluate and refine models through an iterative cycle of comparing their predictions with the real world and then adjusting them to gain insights into the phenomenon being modeled. As such, models are based upon evidence. When new evidence is uncovered that the models can't explain, models are modified.

In engineering, models may be used to analyze a system to see where or under what conditions flaws might develop, or to test possible solutions to a problem. Models can also be used to visualize and refine a design, to communicate a design's features to others, and as prototypes for testing design performance.

Grades K-2	Grades 3-5	Grades 6-8	Grades 9-12
Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions. ▪ Distinguish between a model and the actual object, process, and/or events the model represents. ▪ Compare models to identify common features and differences. ▪ Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s). ▪ Develop a simple model based on evidence to represent a proposed object or tool.	Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. ▪ Identify limitations of models. ▪ Collaboratively develop and/or revise a model based on evidence that shows the relationships among variables for frequent and regular occurring events. ▪ Develop a model using an analogy, example, or abstract representation to describe a scientific principle or design solution. ▪ Develop and/or use models to describe and/or predict phenomena. ▪ Develop a diagram or simple physical prototype to convey a proposed object, tool, or process. ▪ Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.	Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ▪ Evaluate limitations of a model for a proposed object or tool. ▪ Develop or modify a model—based on evidence – to match what happens if a variable or component of a system is changed. ▪ Use and/or develop a model of simple systems with uncertain and less predictable factors. ▪ Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena. ▪ Develop and/or use a model to predict and/or describe phenomena. ▪ Develop a model to describe unobservable mechanisms. ▪ Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales.	Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. ▪ Evaluate merits and limitations of two different models of the same proposed tool, process, mechanism or system in order to select or revise a model that best fits the evidence or design criteria. ▪ Design a test of a model to ascertain its reliability. ▪ Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system. ▪ Develop and/or use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations. ▪ Develop a complex model that allows for manipulation and testing of a proposed process or system. ▪ Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

[Appendix G](#): Crosscutting Concepts / Matrix

NGSS Crosscutting Concepts*

3. Scale, Proportion, and Quantity – In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

K-2 Crosscutting Statements	3-5 Crosscutting Statements	6-8 Crosscutting Statements	9-12 Crosscutting Statements
▪ Relative scales allow objects and events to be compared and described (e.g., bigger and smaller; hotter and colder; faster and slower). ▪ Standard units are used to measure length.	▪ Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods. ▪ Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.	▪ Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. ▪ The observed function of natural and designed systems may change with scale. ▪ Proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. ▪ Scientific relationships can be represented through the use of algebraic expressions and equations. ▪ Phenomena that can be observed at one scale may not be observable at another scale.	▪ The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. ▪ Some systems can only be studied indirectly as they are too small, too large, too fast, or too slow to observe directly. ▪ Patterns observable at one scale may not be observable or exist at other scales. ▪ Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. ▪ Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

4. Systems and System Models – A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

K-2 Crosscutting Statements	3-5 Crosscutting Statements	6-8 Crosscutting Statements	9-12 Crosscutting Statements
▪ Objects and organisms can be described in terms of their parts. ▪ Systems in the natural and designed world have parts that work together.	▪ A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot. ▪ A system can be described in terms of its components and their interactions.	▪ Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. ▪ Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. ▪ Models are limited in that they only represent certain aspects of the system under study.	▪ Systems can be designed to do specific tasks. ▪ When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models. ▪ Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. ▪ Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

Appendix H: Nature of Science

Overview

One goal of science education is to help students understand the nature of scientific knowledge. This matrix presents eight major themes and grade level understandings about the nature of science. Four themes extend the scientific and engineering practices and four themes extend the crosscutting concepts. These eight themes are presented in the left column. The matrix describes learning outcomes for the themes at grade bands for K-2, 3-5, middle school, and high school. Appropriate learning outcomes are expressed in selected performance expectations and presented in the foundation boxes throughout the standards.

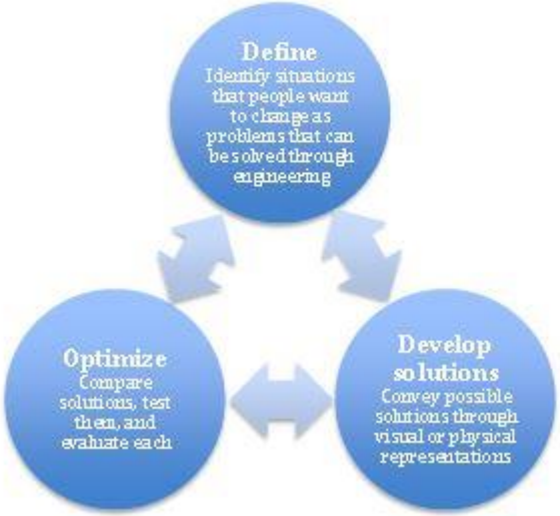
Understandings about the Nature of Science

Categories	K-2	3-5	Middle School	High School
Scientific Investigations Use a Variety of Methods	▪ Science investigations begin with a question. ▪ Science uses different ways to study the world.	▪ Science methods are determined by questions. ▪ Science investigations use a variety of methods, tools, and techniques.	▪ Science investigations use a variety of methods and tools to make measurements and observations. ▪ Science investigations are guided by a set of values to ensure accuracy of measurements, observations, and objectivity of findings. ▪ Science depends on evaluating proposed explanations. ▪ Scientific values function as criteria in distinguishing between science and non-science.	▪ Science investigations use diverse methods and do not always use the same set of procedures to obtain data. ▪ New technologies advance scientific knowledge. ▪ Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. ▪ The discourse practices of science are organized around disciplinary domains that share exemplars for making decisions regarding the values, instruments, methods, models, and evidence to adopt and use. ▪ Scientific investigations use a variety of methods, tools, and techniques to revise and produce new knowledge.
Scientific Knowledge is Based on Empirical Evidence	▪ Scientists look for patterns and order when making observations about the world.	▪ Science findings are based on recognizing patterns. ▪ Science uses tools and technologies to make accurate measurements and observations.	▪ Science knowledge is based upon logical and conceptual connections between evidence and explanations. ▪ Science disciplines share common rules of obtaining and evaluating empirical evidence.	▪ Science knowledge is based on empirical evidence. ▪ Science disciplines share common rules of evidence used to evaluate explanations about natural systems. ▪ Science includes the process of coordinating patterns of evidence with current theory. ▪ Science arguments are strengthened by multiple lines of evidence supporting a single explanation.
Scientific Knowledge is Open to Revision in Light of New Evidence	▪ Science knowledge can change when new information is found.	▪ Science explanations can change based on new evidence.	▪ Scientific explanations are subject to revision and improvement in light of new evidence. ▪ The certainty and durability of science findings varies. ▪ Science findings are frequently revised and/or reinterpreted based on new evidence.	▪ Scientific explanations can be probabilistic. ▪ Most scientific knowledge is quite durable but is, in principle, subject to change based on new evidence and/or reinterpretation of existing evidence. ▪ Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation.
Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena	▪ Science uses drawings, sketches, and models as a way to communicate ideas. ▪ Science searches for cause and effect relationships to explain natural events.	▪ Science theories are based on a body of evidence and many tests. ▪ Science explanations describe the mechanisms for natural events.	▪ Theories are explanations for observable phenomena. ▪ Science theories are based on a body of evidence developed over time. ▪ Laws are regularities or mathematical descriptions of natural phenomena. ▪ A hypothesis is used by scientists as an idea that may contribute important new knowledge for the evaluation of a scientific theory. ▪ The term "theory" as used in science is very different from the common use outside of science.	▪ Theories and laws provide explanations in science, but theories do not with time become laws or facts. ▪ A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that has been repeatedly confirmed through observation and experiment, and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. ▪ Models, mechanisms, and explanations collectively serve as tools in the development of a scientific theory. ▪ Laws are statements or descriptions of the relationships among observable phenomena. ▪ Scientists often use hypotheses to develop and test theories and explanations.

Appendix I: Engineering Design in the NGSS

Grades K-2

Engineering design in the earliest grades introduces students to "problems" as situations that people want to change. They can use tools and materials to solve simple problems, use different representations to convey solutions, and compare different solutions to a problem and determine which is best. Students in all grade levels are not expected to come up with original solutions, although original solutions are always welcome. Emphasis is on thinking through the needs or goals that need to be met, and which solutions best meet those needs and goals.



century society.

Performance Expectations That Incorporate Engineering Practices

	Physical Science	Life Science	Earth and Space Science	Engineering
K	K-PS2-2 K-PS3-2		K-ESS3-2 K-ESS3-3	K-2-ETS1-1 K-2-ETS1-2 K-2-ETS1-3
1	1-PS4-4	1-LS1-1		
2	2-PS1-2	2-LS2-2	2-ESS2-1	
3	3-PS2-4	3-LS4-4	3-ESS3-1	3-5-ETS1-1

Appendix J: Science, Technology, Society, and the Environment

The following matrix summarizes how the two core ideas discussed in this chapter progress across the grade levels.

1. Interdependence of Science, Engineering, and Technology			
K-2 Connections Statements	**3-5 Connections Statements**	**6-8 Connections Statements**	**9-12 Connections Statements**
• Science and engineering involve the use of tools to observe and measure things.	• Science and technology support each other. • Tools and instruments are used to answer scientific questions, while scientific discoveries lead to the development of new technologies.	• Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. • Science and technology drive each other forward.	• Science and engineering complement each other in the cycle known as research and development (R&D). • Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.

2. Influence of Engineering, Technology, and Science on Society and the Natural World			
K-2 Connections Statements	**3-5 Connections Statements**	**6-8 Connections Statements**	**9-12 Connections Statements**
• Every human-made	• People's needs and	• All human activity draws on	• Modern civilization depends on

Appendix K: Model Course Mapping in Middle and High School (coming soon)

Modified Science Domains Model (9-12)

Biology

LS1.A	HS-LS1-a
	HS-LS1-b
	HS-LS1-c
	HS-LS1-d
LS1.B	HS-LS1-e
	HS-LS1-f
	HS-LS1-g
	HS-LS3-c
LS1.C	HS-LS1-h
	HS-LS1-i
	HS-LS1-j
	HS-LS2-d
	HS-LS2-g
	HS-LS2-e
	HS-LS2-c
LS1.D	HS-LS1-k
	HS-LS1-l
LS2.A	HS-LS2-a
	HS-LS2-b
LS2.B	HS-LS1-i
	HS-LS1-j
	HS-LS2-d
	HS-LS2-g
	HS-LS2-e
	HS-LS2-f
LS2.C	HS-LS2-h
	HS-LS2-i
	HS-LS2-j
	HS-LS2-b
LS2.D	HS-LS2-k
LS3.A	HS-LS3-a
	HS-LS3-b
	HS-LS3-d
LS4.A	HS-LS4-f
LS4.B	HS-LS4-b
	HS-LS4-d
	HS-LS4-c
	HS-LS4-e
LS4.C	HS-LS4-b
	HS-LS4-d
	HS-LS4-c
	HS-LS4-e
	HS-LS4-a
LS4.D	HS-LS2-l
	HS-LS2-j
ESS1.C	HS-ESS1-g
	HS-ESS1-i
	HS-ESS1-j
	HS-ESS1-h
ESS2.E	HS-ESS1-l
ESS3.B	HS-ESS3-c
	HS-ESS3-d
ESS3.C	HS-ESS3-e
	HS-ESS3-f

Chemistry

PS1.A	HS-PS1-a
	HS-PS1-b
	HS-PS1-c
	HS-PS2-f
	HS-PS1-d
	HS-PS1-j
	HS-PS3-g
PS1.B	HS-PS1-e
	HS-PS1-f
	HS-PS1-g
	HS-PS1-h
	HS-PS1-i
PS2.C	HS-PS1-g
PS3.B	HS-PS3-d
PS3.D	HS-PS3-d
ESS2.C	HS-ESS2-i
ESS2.D	HS-ESS2-j
	HS-ESS2-k
	HS-ESS2-e
	HS-ESS2-f
	HS-ESS3-g
	HS-ESS3-h
ESS3.A	HS-ESS3-a
	HS-ESS3-b
ESS3.D	HS-ESS3-i
	HS-ESS3-g
	HS-ESS3-h

Physics

PS2.A	HS-PS2-a
	HS-PS2-b
	HS-PS2-c
PS2.B	HS-PS2-d
	HS-PS2-e
PS2.C	HS-PS1-g
	HS-PS2-b
	HS-PS2-c
PS3.A	HS-PS3-a
	HS-PS3-b
	HS-PS3-c
PS3.B	HS-PS3-a
	HS-PS3-b
	HS-PS3-d
	HS-PS3-f
PS3.C	HS-PS3-e
PS4.A	HS-PS4-a
	HS-PS4-b
	HS-PS4-c
	HS-PS4-d
PS4.B	HS-PS4-a
	HS-PS4-e
	HS-PS4-f
	HS-PS4-g
	HS-PS4-h
ESS1.A	HS-ESS1-b
	HS-ESS1-c
	HS-ESS1-a
	HS-ESS1-d
ESS1.B	HS-ESS1-e
	HS-ESS1-f
ESS2.A	HS-ESS2-c
	HS-ESS2-d
	HS-ESS2-a
	HS-ESS2-b
	HS-ESS2-e
	HS-ESS2-f
	HS-ESS2-g
	HS-ESS2-h
ESS2.B	HS-ESS2-d
	HS-ESS2-a
	HS-ESS1-h

KEY

(yellow)	PE appears in more than one DCI in the same course.
(blue)	PE shared across more than one course because a component idea is divided between courses.
(green)	PE appears in more than one course and it is connected to more than one DCI component idea in the same course.

NEXT GENERATION SCIENCE STANDARDS
For States, By States

Appendix L: Connections to Common Core Mathematics (coming soon)

5.ESP Earth Surface Processes

As part of this work, teachers should give students opportunities to **use the coordinate plane**:

> 5.G.2. Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation. *Science example: Plot monthly data for high and low temperatures in two locations, one coastal and one inland (e.g., San Francisco County vs. Sacramento). What patterns do you see? How can the influence of the ocean be seen in the observed patterns?*

Alignment notes: (1) Trends in scatterplots and patterns of association in two-way tables are not expected until Grade 8.

5.SS Space Systems: Stars and the Solar System

As part of this work, teachers should give students opportunities to **use the coordinate plane**:

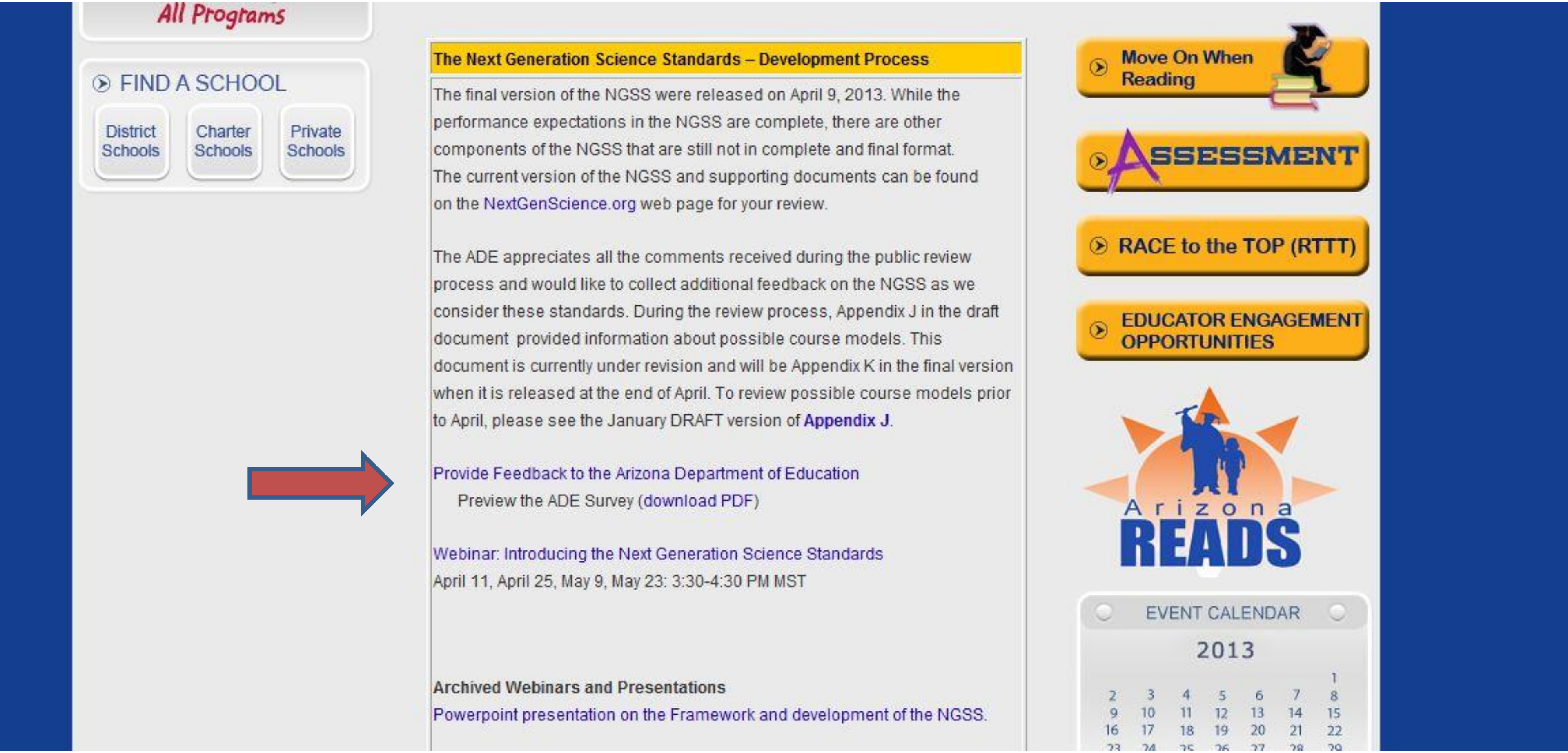
> 5.G.2. Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation. *Science examples: (1) Over the course of a year, students compile data for the length of the day over the course of the year. What pattern is observed when the data are graphed on a coordinate plane, and how can a model of the sun and Earth explain the pattern? (2) Students are given (x,y) coordinates for the Earth at six equally spaced times during its orbit around the sun (with the sun at the origin). Students graph the points to show snapshots of Earth's motion through space.*

NEXT GENERATION SCIENCE STANDARDS

For States, By States

Providing Feedback For Support of NGSS

http://www.azed.gov/standards-practices/next-generation-science-standards/



ADE Feedback Survey

Strengths and Weaknesses

The following questions ask about the strengths and weaknesses of the Next Generation Science Standards.

18. I support Arizona adopting science standards that are common and shared with other states.*

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

19. I support the State Board of Education adopting the Next Generation Science Standards as Arizona's science standards.*

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

20. Please comment about whether Arizona's State Board of Education should adopt the Next Generation Science Standards as Arizona's Science Standards.

NEXT GENERATION SCIENCE STANDARDS
For States, By States

What questions do you have?